

## STAB WOUNDS OF THE HEART.\*

WITH REPORT OF A CASE.

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IT has been the general impression on the part of the world at large that all wounds of the heart, no matter how trifling, so long as the pericardium was injured, the injury must be necessarily fatal. This was the accepted opinion of all of the older surgical writers. Hallerius appears to be the first to differ from this old accepted theory, and to assert that heart wounds were not necessarily fatal. It would seem as though these conclusions might have been arrived at long before, especially when hand-to-hand combat was so common, and, from the very nature of the arms employed, punctured wounds of the heart must have been very frequent. Many non-penetrating wounds of the heart must have recovered, and persons sustaining penetrating wounds must have often lived for some time, and were capable of making considerable exertion. To bear out this statement I recall a case which occurred when I was a resident at the Pennsylvania Hospital, in which a sailor was stabbed on board ship with a sailor's sheath knife (an ordinary butcher knife) which inflicted a penetrating wound from  $1\frac{1}{4}$  to  $1\frac{1}{2}$  inches in length in the left ventricle. The patient lived about two hours, but died shortly after his admission to the ward, apparently from the loss of blood and embarrassment of the heart's action due to a pericardium distended with blood clots.

Wolf, as long ago as 1642, gave the first reliable account of the healing of a heart wound. Later Desoult described the steps of an operation for the relief of pericardial empyema. In 1798 many cases were reported of heart wounds in which pro-

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tracted periods intervened between the receipt of the injury and death. Up to the end of the nineteenth century the treatment of heart wounds was purely expectant, consisting of rest, ice, cardiac sedatives, blisters, etc., etc.

In 1881 Dr. John B. Roberts suggested the propriety of attempting to suture the heart muscle in cases of stab-wounds. This idea, however, did not meet with much encouragement, as so distinguished a surgeon as Billroth declared that a surgeon who wished to retain the respect of his confrères would not attempt such a procedure.

Again, as the result of experimental research much light has been thrown upon the future of heart surgery, which may be voiced by the statements of Elsberg, quoted by Stewart in his classic paper on this subject.

The consensus of opinion among experimenters is, that the heart after being exposed can be grasped with the hands or forceps and gently compressed with no appreciable effect on its action; that punctures with needle or knife produce only a temporary irregularity in the heart's action; that wounds produced during systole bleed more than those occurring during diastole; that wounds of the ventricle produced during systole are larger than those produced during diastole; that oblique wounds bleed more than perpendicular wounds; that wounds of the right ventricle are more dangerous, because of the thin ventricular wall and because the blood in the right heart coagulates more slowly; that wounds of the heart heal kindly, and that the cicatrix is complete in two weeks; that interrupted sutures are better than continuous ones; that the material enclosed in the grasp of the sutures causes atrophy and is replaced by scar tissue; that superficial stitches are less liable to tear out than deeper ones, and that the stitches should be inserted and tied during diastole, because of the danger of tearing out during systole.

It will be seen that some of these opinions are of practical importance, while others are theoretical and impossible to carry into effect.

With this much learned as the result of experimental

research, two unsuccessful attempts were made in 1896 at cardiorrhaphy, and a year later Rehn published the report of the first successful operation. Since that time a number of successful cases have been reported, two by Fellows of this Academy, Dr. Stewart and Dr. Gibbon.

The heart may be wounded by all kinds of vulnerating bodies producing punctured, incised, lacerated and gunshot wounds, all of which may be received in a great variety of ways. In a large percentage of cases the pleura will be wounded. In a number of cases carefully analysed by Stewart, it was found that the pleura was wounded. Gibbon, however, was fortunate in his two cases not to have the pleura injured, which is of great advantage, preventing much of the danger from infection.

The symptoms following a penetrating wound of the heart vary greatly under different conditions. There are always varying degrees of shock which depend largely upon the size and character of the wound. If the pleura is opened and the wound is sufficiently large extensive haemorrhage may take place into the pleural cavity. Or, on the other hand, blood may pour out into the pericardium or externally. Auscultation produces a variety of symptoms, such as a splashing sound, indicating air and blood in the pericardium: sometimes a friction sound will be noticed, and in other instances a bruit, as though an aneurism existed. The heart's action is irregular and often very labored. The pulse may be less than 100. If the blood is confined to the pericardium the praecordial dulness will be greatly increased on percussion. (Upon these facts I based my diagnosis in the case which I here report.) The pulse will be very feeble and the apex-beat can be neither felt nor heard. The pressure manifests itself first on the auricles and the origin of the great veins, causing venous stasis, which may manifest itself by dyspncea and cyanosis. the ventricles having a tendency to pump themselves dry, and the heart finally ceasing to act. Without surgical intervention the individual will die from anæmia, compression of the heart, or, later, from sepsis or functional incompetence.

From what has been surmised it would appear that the diagnosis of wounds of the heart could be made without much difficulty. But at times a positive diagnosis can only be determined upon by an exploratory operation. For instance, in punctured wounds involving the praecordium where the internal mammary and intercostal arteries are injured a violent haemorrhage may ensue which may confuse the condition, with that of a penetrating wound of the heart. The size of the wound of entrance is no index to the size of the wound in the heart, which may be greatly increased either owing to the heart's action or to the position and movement of the wounding instrument.

Stewart quotes Fisher, who analyzed 452 heart wounds, and says that from 7 to 10 per cent. of these cases recover spontaneously. This estimate seems high, but even if it were positive it should not deter one from prompt surgical intervention if the patient's condition warrants it. The prognosis in these injuries depends upon the kind and extent of the wound inflicted, and last, but in no wise least, upon whether or not there is infection, especially of the pleural cavity. Gibbon, in an unpublished paper, is disposed to think from an analysis of the reported cases that gunshot wounds of the heart would give a higher recovery rate than stab-wounds, if it were not for the injury of other viscera which nearly always accompanies gunshot wounds, especially injury to the lung and pleura. There are 19 cases on record where bullets have lodged either in the heart muscle or cavity, and in which the patients have lived for varying periods after receipt of the injury. It may be fair to presume that an individual who lives a couple of hours after the receipt of a heart wound has a fair chance to recover with an operation. Many cases which succumb in a short time, would recover if they could have prompt surgical intervention.

In operating on these cases an anæsthetic seems imperative. Except when the patient is unconscious ether is unquestionably the anæsthetic to be preferred. Time is an important factor, and every provision should be made beforehand so that the steps of the operation may go on without any interruption. As

to the incision for the exposure of the heart, this depends in a measure on the exigency of the case. If possible the incision should be so planned as not to involve the pleura. It is questionable, however, if any operative technique will ever be established for dealing satisfactorily with these cases. The formal osteoplastic flap, as employed by the Continental surgeons for exposing the heart, is liable to result in injury to the pleura, and is not to be classed with the simple suprapleural operation where two or more costal cartilages, and if necessary, a portion of the rib, can be divided and reflected back over the sternum. With care the pleura and pericardium are easily separated from the overlapping tissues, giving the operator every facility to open the pericardium without involving the pleura. In my own case I erred by following the course of the wound through the pleura, thus causing immediate collapse of the lung, and forming later a favorable field for infection. After a satisfactory exposure of the pericardium it should be opened with a blunt pair of scissors, after carefully raising the pericardium from the heart with forceps, as the latter will be floated or pushed forward if much haemorrhage has taken place, into the pericardium. Loose blood and clots should be quickly sponged out, when usually the bleeding spot can be felt or seen, and controlled by pressure until sutures can be introduced.

The best suturing material is chromicized catgut, reasonably fine, introduced on a sharply curved needle. Each stitch should be left long after tying, as the ends materially assist as tractors and enable the more accurate introduction of the subsequent stitches. It will be found in many cases that the heart's action is very rapid and erratic, and that the introduction of the first suture is like attempting to perform the same operation in the back of a fish which has just been taken from the water and is still impaled on the hook. In ventrical wounds the sutures should be inserted deeply, even to entering the endocardium, as only by this means can accurate approximation be procured. In wounds of the auricle through-and-through sutures are imperative, as well as several superficial ones, as bleeding sometimes takes place through the suture wound, as experienced

in my case. This, however, can be easily controlled by a few superficial stitches inserted at the bleeding point. In introducing the sutures everything should be sacrificed in order to obtain accurate approximation of the wound. If the line of suture should involve the coronary artery little harm is likely to result if it is caught in the suture. This occurred in Gibbon's case without ill effect. Ricketts also showed in experimental work on the dog that either coronary artery could be tied without harm.

In wounds where the lung is also injured considerable bleeding may take place from the lung substance, but when there is an opening of any size in the pleura the lung invariably collapses. This in itself may be sufficient to control the bleeding point. This failing, however, several deep sutures may be inserted into the lung substance at the bleeding point and firmly tied. The pericardium should be closed with a continuous cat-gut suture without drainage, as this cavity is much less apt to become infected than the pleura, and it is the best practice to close the pericardium in this way, although it is just the reverse with the pleura. If the lung is collapsed, the pleural cavity if possible should be cleansed of all free blood and clots, and if the patient's condition admits, provision should be made for drainage by an opening in a dependent part of the chest. No power can prevent infection in a wound where air is drawn into the pleura with each inspiratory act.

It will be also noticed that when the heart has lost its natural support by the surrounding lung, owing to its collapsing, it will immediately begin to become more erratic in its action and to race in a most excited manner. This can, in a great measure, be overcome by loosely packing the large space with liberal pads of gauze wet with salt solution. This was very noticeable in my case, and it seemed as though the heart would almost jump out of the chest until surrounded and supported by the moist packs of gauze.

The after-treatment of these cases is simply routine, in which small doses of morphia may be employed to advantage.

W. W., aged twenty-one, colored, longshoreman, was ad-

mitted to the Pennsylvania Hospital on June 9, 1906, with a stab-wound of the left chest, in third interspace to the left of the sternum, inflicted with a long-bladed pocket knife. The wound was about  $\frac{1}{2}$  inch in length. On admission the patient was somewhat shocked but did not complain much of pain. After being placed in bed reaction took place, and when seen by me two hours later the heart's action was fairly good; the pulse was about 120 and could be readily felt at the wrist. On auscultation, however, it could be seen that the heart was laboring very considerably, the sounds being very indistinct and muffled. The praecordial dulness had very much increased and had been gradually doing so since his admission, as noticed by Dr. Drayton, the resident physician, and it was very evident that the knife had entered the pericardium and wounded the heart. Operation was immediately decided upon. The patient was etherized and an incision about 4 inches long made to the left of the sternum, following the line of the wound, which had opened the pleura. The two ends of the fourth and fifth costal cartilages were removed from their attachment to the sternum, which, with the aid of a retractor, freely exposed the pericardium. It was noticed that the lung was partially collapsed, and the heart was laboring very much within the exposed pericardium. The pericardium was freely incised and found full of clot, which was rapidly removed and a wound about  $\frac{1}{2}$  inch in length found in the left auricle, from which a stream of blood squirted to a height of about 9 inches. The heart's action on the removal of the clot became fearfully rapid, and it was with the greatest difficulty that a number of sutures were introduced into the auricle, which was finally closed with chromicized gut. It was rather curious to note that immediately on the introduction of the first stitch the size of the blood stream from the auricle was reduced, but in place of one stream there were four, two small ones coming from the needle wounds. Two stitches were introduced through and through the auricle and these had to be fortified by a number of superficial stitches. In a few minutes all bleeding was permanently controlled. After thorough cleansing of the pericardium it was sutured. Apparently owing to the lack of support which the heart did not receive from the collapsed lung, its action was very violent and erratic. Two large section pads were placed behind the pericardium saturated with normal salt solution, and

the heart and respiration immediately became more normal. One pad was placed on top of the pericardium and brought out through the incision. The lower end of the incision was approximated with silk-worm gut. The patient reacted well from the operation. Subsequent to operation his pulse was of rapid but fair quality, about 120 to 140, and respirations ranged from 56 to 72.

The third day after operation the pads were removed and the patient's general condition was good. The following day the superficial drain was removed and another inserted; the left chest was strapped, which materially assisted the breathing. It was very evident that infection had taken place in the chest, as the discharge became very profuse and foul. On June 29 a rib was resected and a drainage tube inserted in the posterior axillary line. For some reason this did not drain satisfactorily. On July 3 another incision was made and the seventh and eighth ribs were resected in the postscapular line, and a tube inserted, but this did not in any way relieve the condition, and shortly after the removal of these two ribs the patient died.

The autopsy showed an empyema of the left chest, which drained badly. The left lung had collapsed, and was the seat of a bronchial pneumonia. The right chest contained 11 ounces of bloody fluid, and there was also a bronchial pneumonia of this side. There were extensive pericardial adhesions with no sign whatever of the stab-wound. The endocardium and valves were healthy.